



ASM Student Technology & Career Night

Jeff Hamilton

NASA Marshall Space Flight Center

March 31, 2005



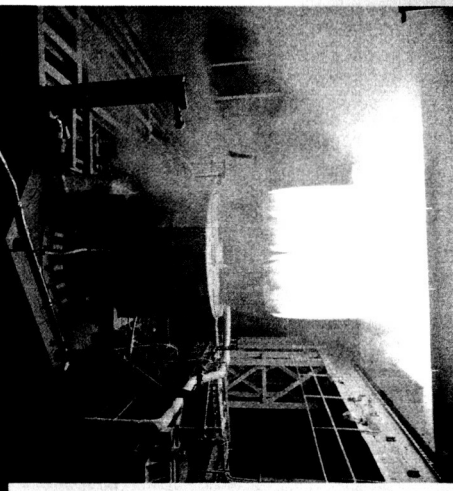
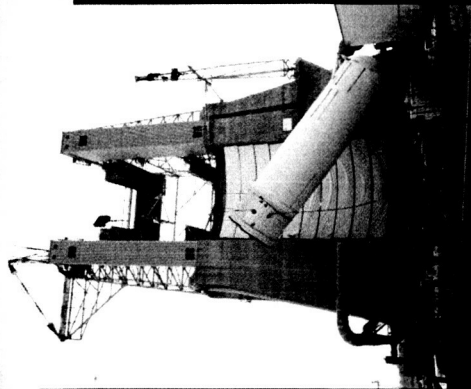
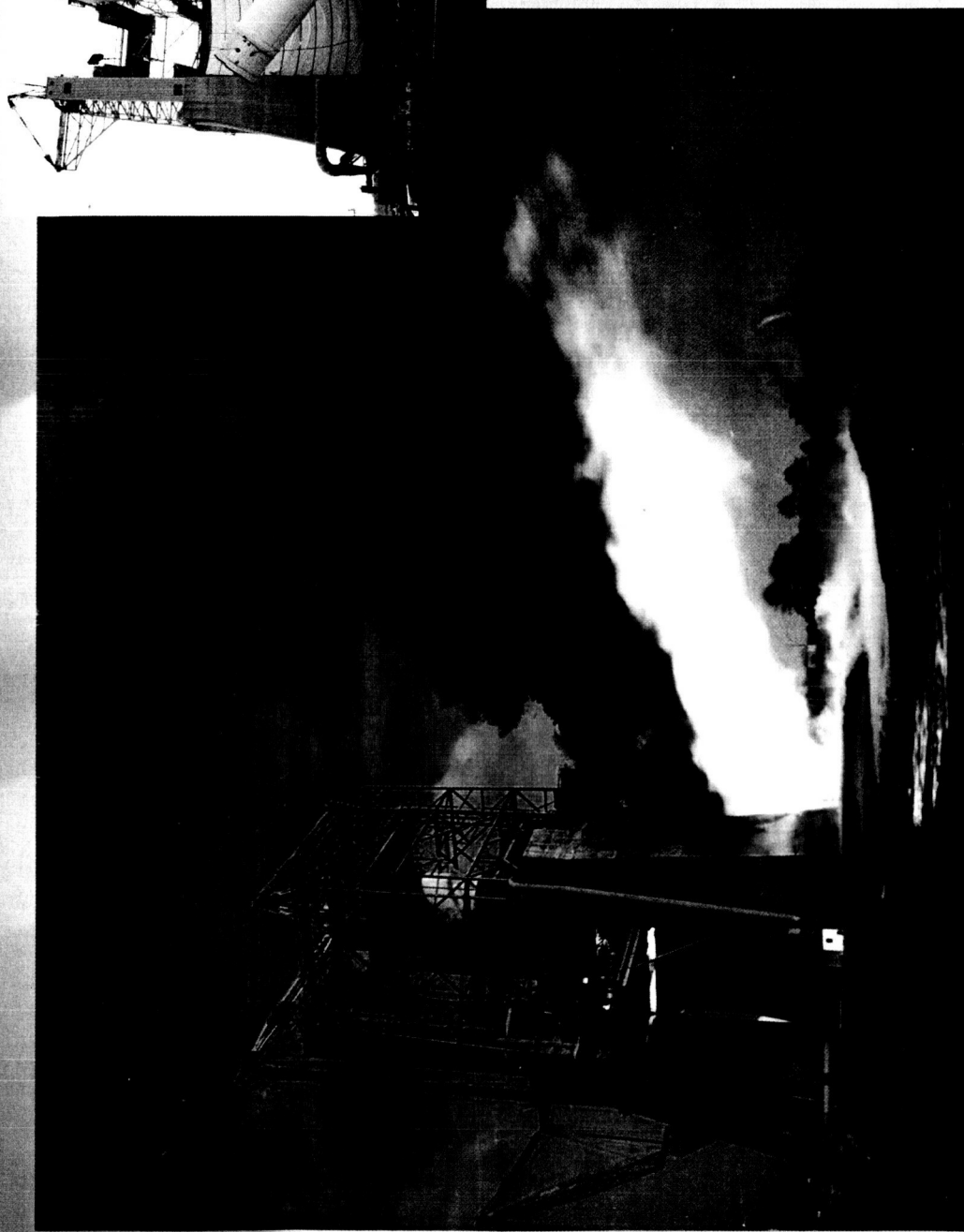
Brief Bio

- Born 1958 (same as NASA!)
 - Grew up on a farm on Brindlee Mountain in Morgan County
 - Could see and hear Saturn testing at MSFC in early 60's
- Attended Union Hill Elementary and Junior High
- Graduated from Albert P. Brewer High School in 1977
 - Mrs. Holland, English
 - Mr. Thomaskutty, Physics, Chemistry
- Attended The University of Alabama in Huntsville 1977-1981
 - Dave Green, EE
 - Co-op Program
- I have a Bachelor of Science in Engineering degree with Electrical specialty
- Started NASA career as an electrical engineering co-op student in 1979
- Became a full-time employee in 1981



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S-IC Solid Rocket History





So you want to work for NASA...

- MSFC is not hiring right now.
- MSFC was not hiring when I graduated either.
- The co-op program is probably the best way for new graduates to get in, but it is highly competitive and is subject to budgets like everything else.
- The few people hired in the last couple years are mostly experienced engineers and scientists with specialized degrees or training.
- By the time you graduate, the situation will have changed and opportunities should be much better.
- Don't give up your dream.



MSFC – A Foundation for the Future



Concept
Development



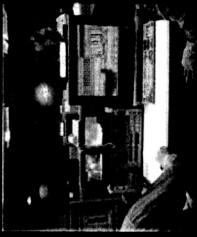
Hardware
& Systems
Development



Systems
Engineering
& Integration



Launch
Support



Flight
Operations

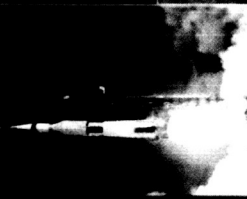
Human Space Flight

- Transportation Systems
 - Propulsion Technologies
 - Surface
- Space Systems
 - Modules
 - Payloads
- Science

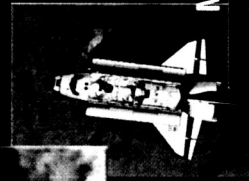
Space Systems

- Transportation Systems
 - Propulsion Technologies
- Space Systems
 - Instrument
 - Integration
- Science

Apollo



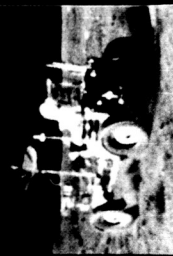
Shuttle



Mir



Moonbuggy



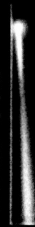
Chandra



Gravity Probe-B



Solar Sail



Prometheus





Engineering Directorate



Instrument & Payload Systems

- Embedded Controls
- Power Electronics
- Software
- Data Systems
- Imaging
- EEE Parts & Packaging
- Electronic Boxes
- Instruments
- Small Mechanical Systems
- ECLSS Components
- Instruments & Payloads
- Fabrication & Assembly Services

Spacecraft & Vehicle Systems

- Vehicle Systems Engineering & Integration
- Tank/Structures Design
- Flight Mechanics
- Avionics/IVHM
- Loads & Dynamics
- Mechanisms
- Terrestrial & Space Environments
- ECLSS Systems
- Aero-Thermal
- Induced Environments
- Modeling & Simulation
- Guidance Navigation & Controls

Propulsion Systems

- Nuclear Propulsion
- Propulsion Engineering
- In-Space Propulsion
- Liquids & Solids
- Component Design
- OMS/RCS
- CFM
- Fluid Systems Design & Analysis
- Propellants & Combustion
- Tank Requirements & Size

Mission Operations

- Ops Concepts
- Ground Systems
 - Design Development
 - Delivery and Cert. Operation
 - Data Delivery and storage
- Flight Operations
 - Ops Assessments
 - Mission Design
 - Crew Procedures
 - Crew Training
 - Flight Controller Cert.
 - On-board Facility Ops
 - Mission Time lining

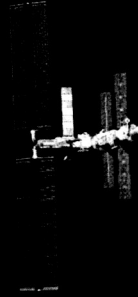
Materials & Processes

- Environmental Effects
- Fracture & Failure Analysis
- NDE & Tribology
- Chemistry & Combustion Research
- Metallics
- Composites & Ceramics
- NCAM

Test

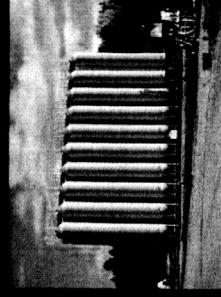
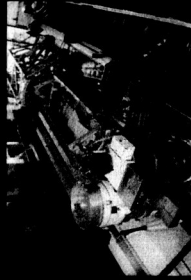
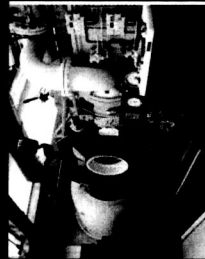
- Propulsion Test
- Structural Test
- Thermal Vacuum
- Shock & Vibration
- Acoustic
- Hot Gas
- Experimental Fluids Test & Development
- Special Test Equipment Design
- Propellants/Pressurants & Calibration
- Advanced Instrumentation Application

Engineering excellence enabling our customers' mission success.





Test Laboratory



Propulsion Test

- Sub-scale injectors & elements, thrusters, gas generators, turbopumps
- Oxygen & Hydrogen cold flow
- Cryostructural
- On-orbit vacuum environment
- Solar thermal propulsion
- Solid motor propellant & materials
- Hot gas material characterization
- Engine Systems (LH_2 , CH_4 , RP-1)
- Air & water flow
- Full flow air blow down for turbopump turbine inlet testing
- Subscale nozzle internal contours & back pressure data via blow down testing
- Pump impeller & inducer sub- & full-scale performance mapping via visual water flow testing
- Subsonic & supersonic vehicle model & nozzle testing at Mach 0.2-5.0
- Air blow down testing of subscale solid motor casing & nozzle designs
- Probe calibration testing

Experimental Fluid Dynamics Test

Environmental Test

- Thermal vacuum
- Thermal cycle/humidity
- Altitude
- Launch ascent/descent
- Vacuum bakeout
- Optical certification
- Arc Jet/Hot Gas
- Development, qualification, acceptance, & research testing of space flight hardware
- Experimental modal analysis to verify & correlate analytical finite element models of space flight hardware
- Vibration, acoustic, & pyrotechnic shock testing for space flight hardware development, qualification & acceptance
- Micro-gravity vibration emission testing

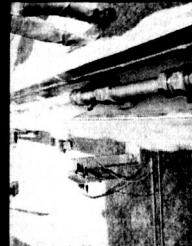
Structural Strength Test

- Hazardous structural test
- Cryostructural test
- Tensile & compressive loads test
- Combined Environments
- Load environments to simulate launch, on orbit, & landing conditions for development, qualification, acceptance & research testing of space flight hardware

Test Support

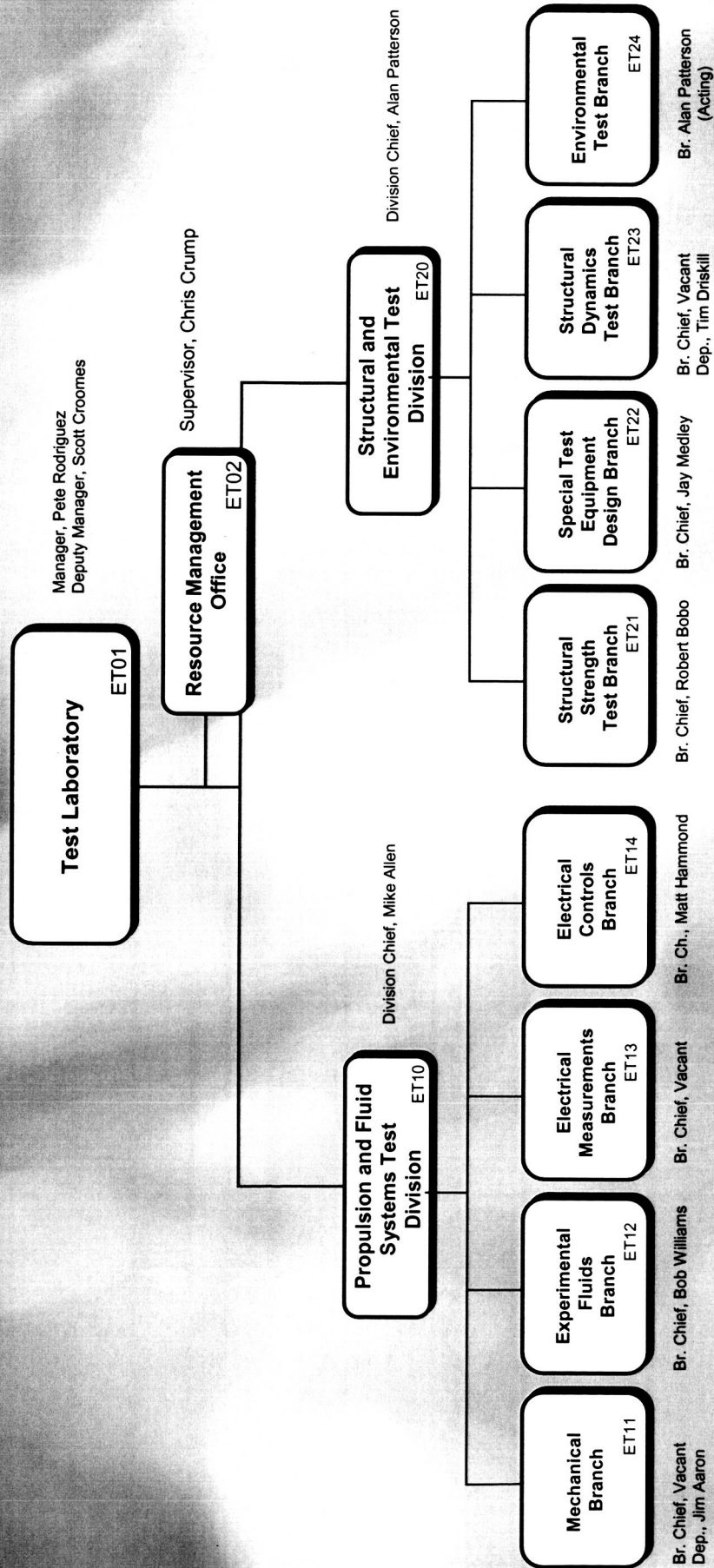
- Propellants, Pressurants & Calibration
- Advanced Instrumentation Applications
- Special Test Equipment Design
- Test Planning
- Emerging Technologies
- Data System & Software Development

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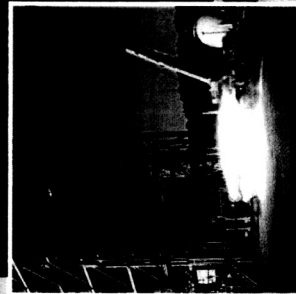
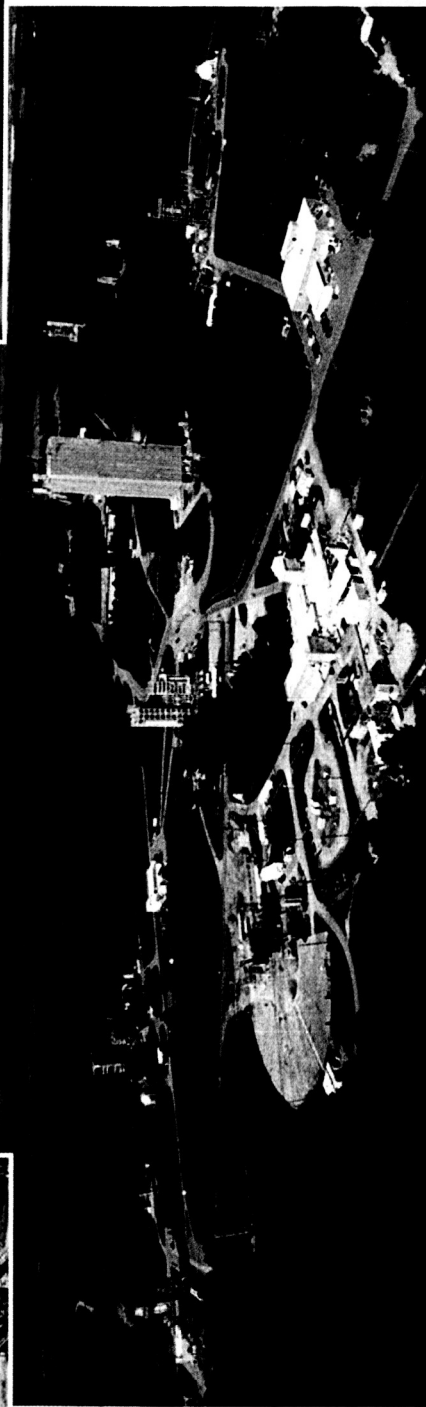
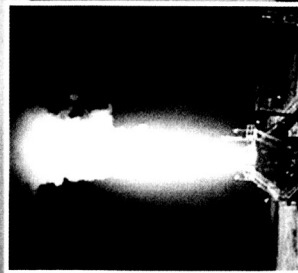
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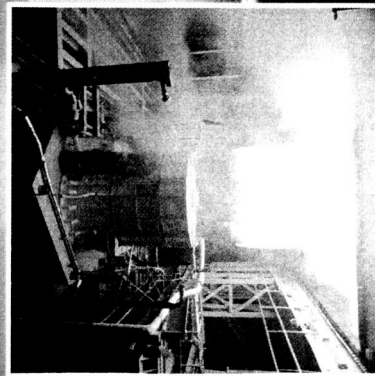
Eastern Area





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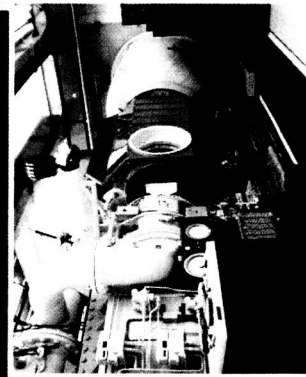
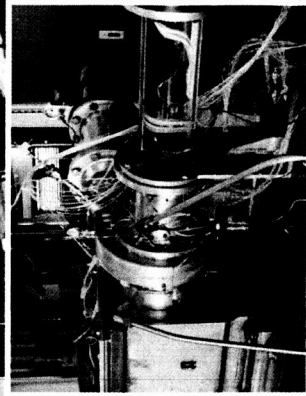
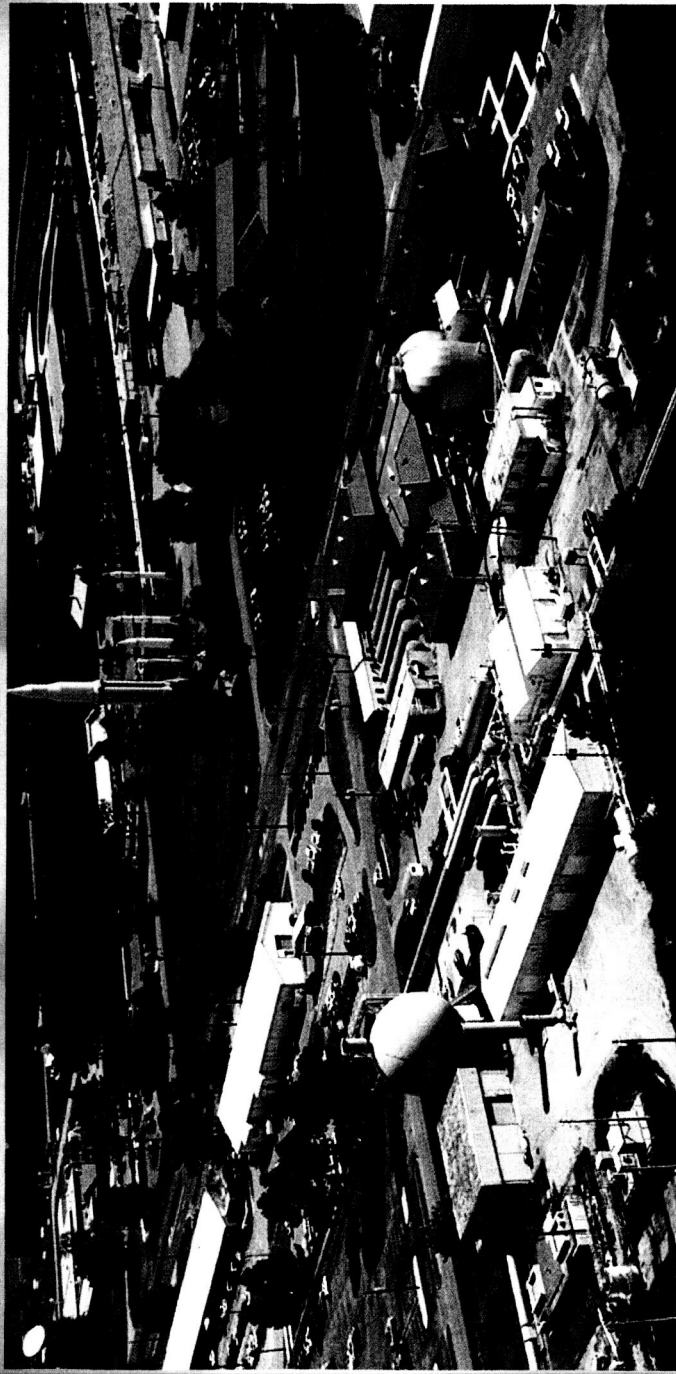
West Area





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North Test Area





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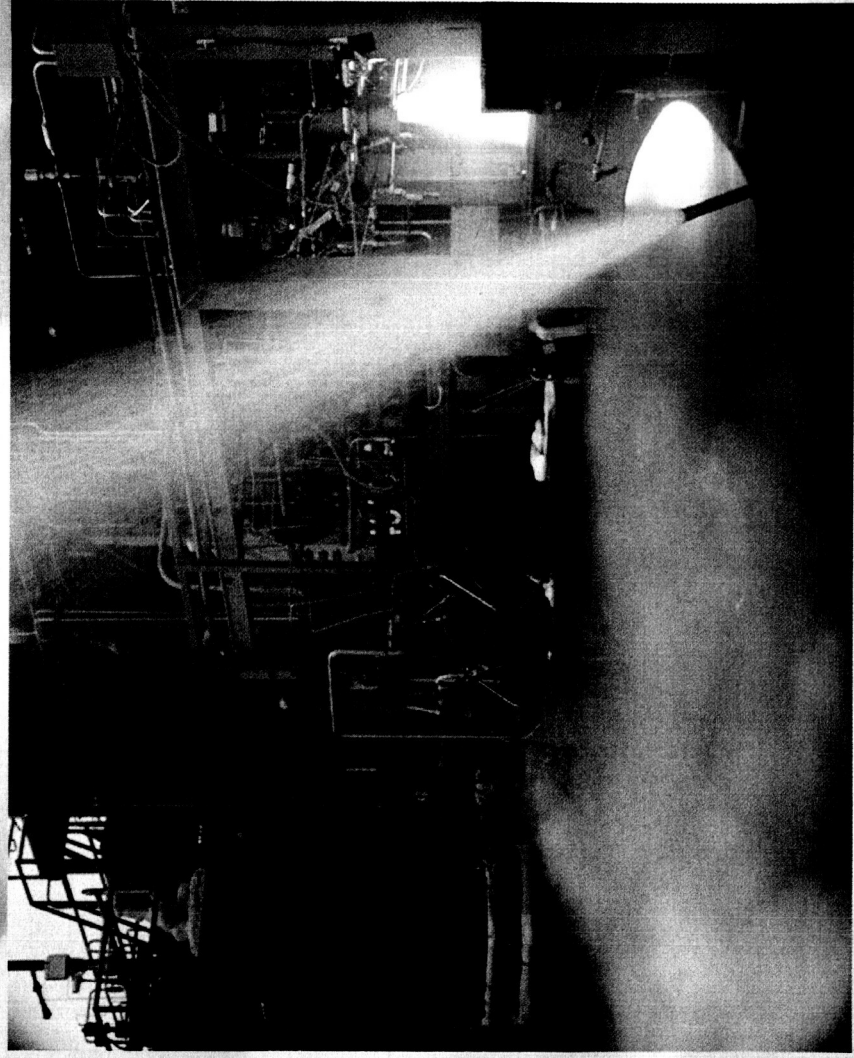
Propulsion Capabilities

- Sub-scale injectors, injector elements, thrusters, gas generators, turbopumps, igniters
- Oxygen and Hydrogen cold flow
- Cryo-structural tank testing
- On-orbit vacuum environment simulation
- Solar thermal propulsion
- Solid motor propellant and materials
- Hot gas material characterization
- Engine Systems, (LH_2 , CH_4 , & RP-1)
- Experimental fluid dynamic air and water flow testing
- Full flow air blow down for turbopump turbine inlet testing
- Subscale nozzle internal contours & back pressure data via blow downs
- Pump impeller and inducer sub- and full-scale performance mapping via visual water flow testing
- Subs & supersonic vehicle model and nozzle testing at Mach 0.2-5.0
- Air blow down testing of subscale solid motor casing & nozzle designs
- Probe calibration testing



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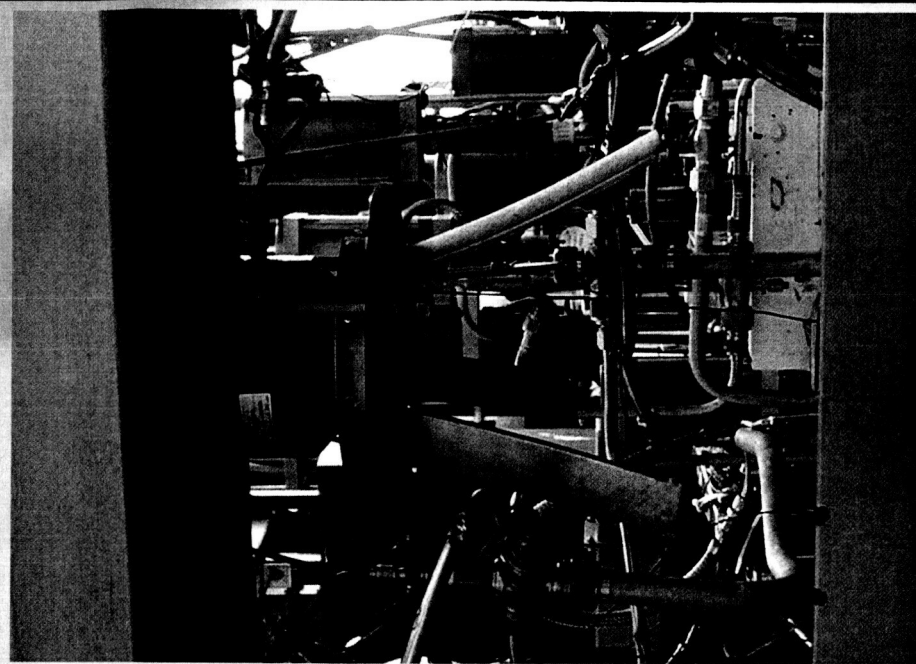
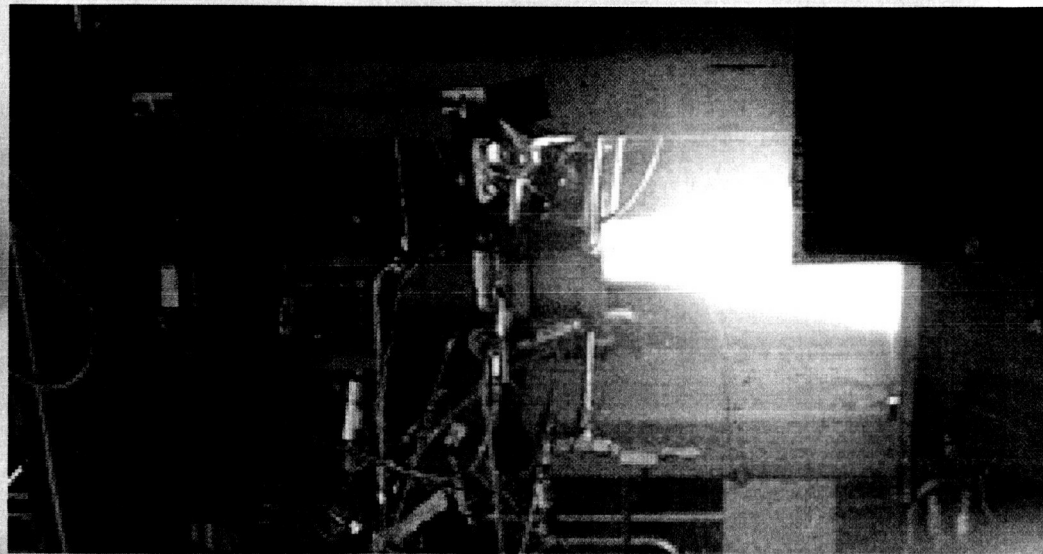
Vortex Tunnel for Testing





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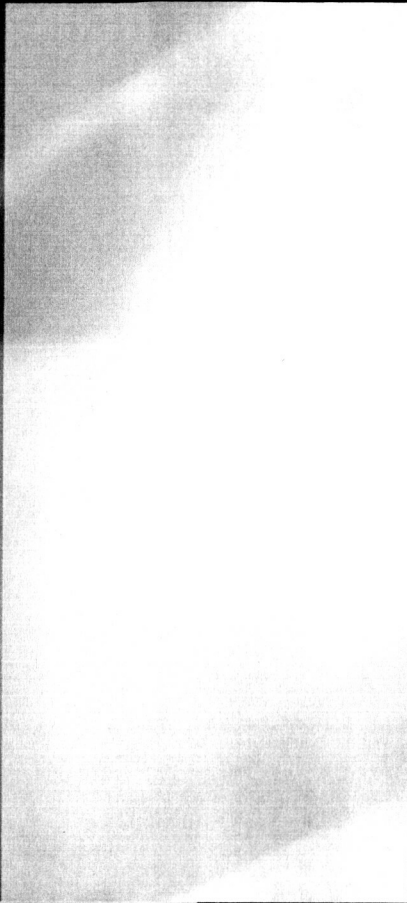
Vortex Tube Air Testing





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LOX/Ethanol Hot Firing





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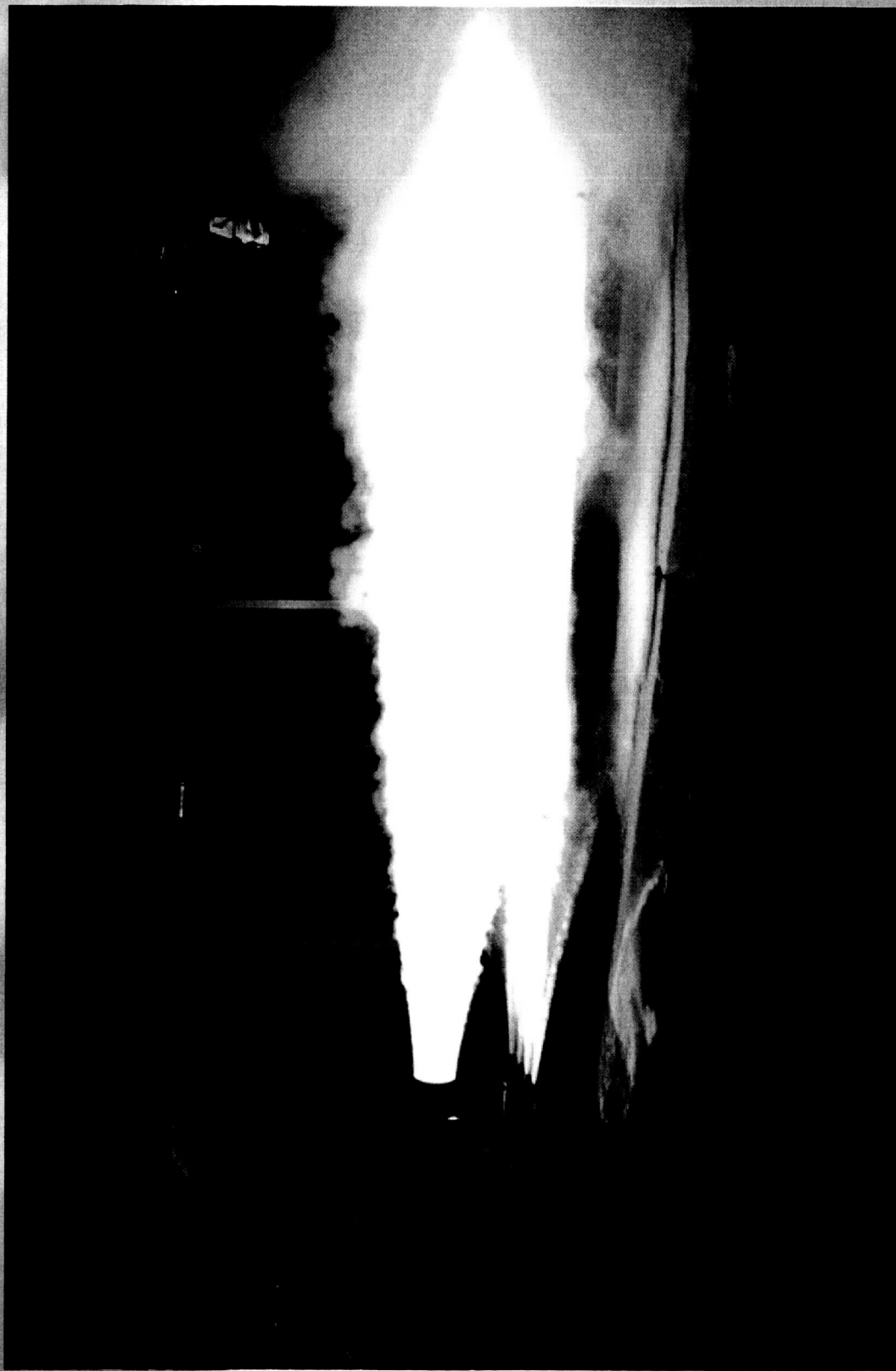
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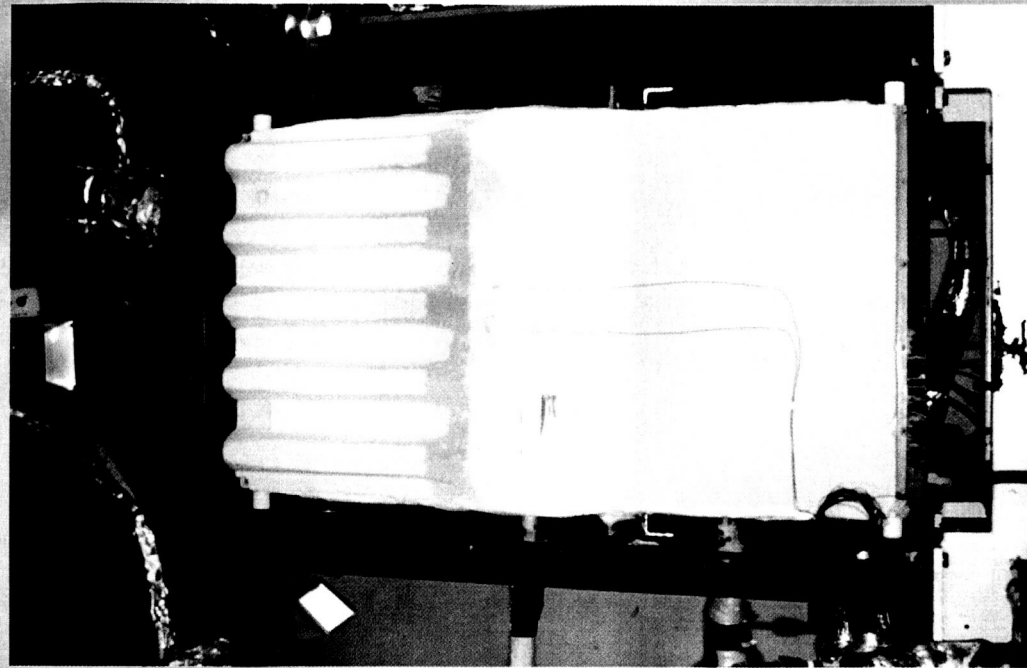
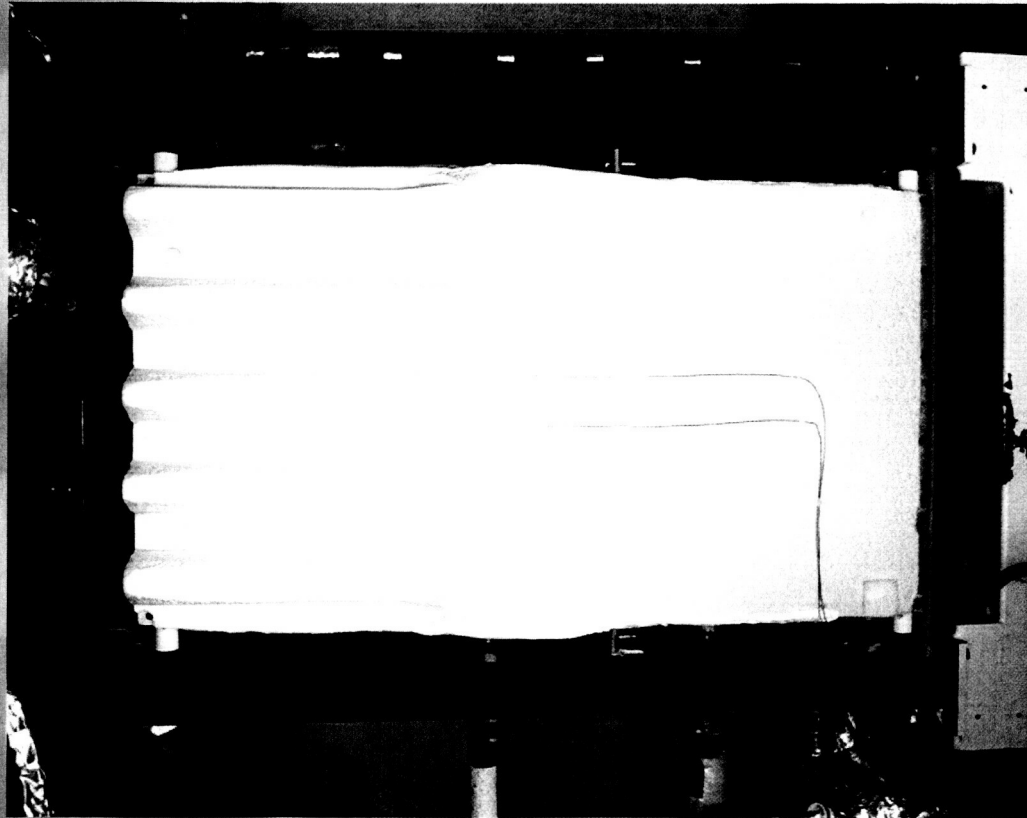
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Foam Test Cell Erosion Profile





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Hot Gas



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LMC-MAF

NCFI 27-68 @ MSFC IHGF
Plan 826-2048-110
Post Test Photographs
IHGF

Panel

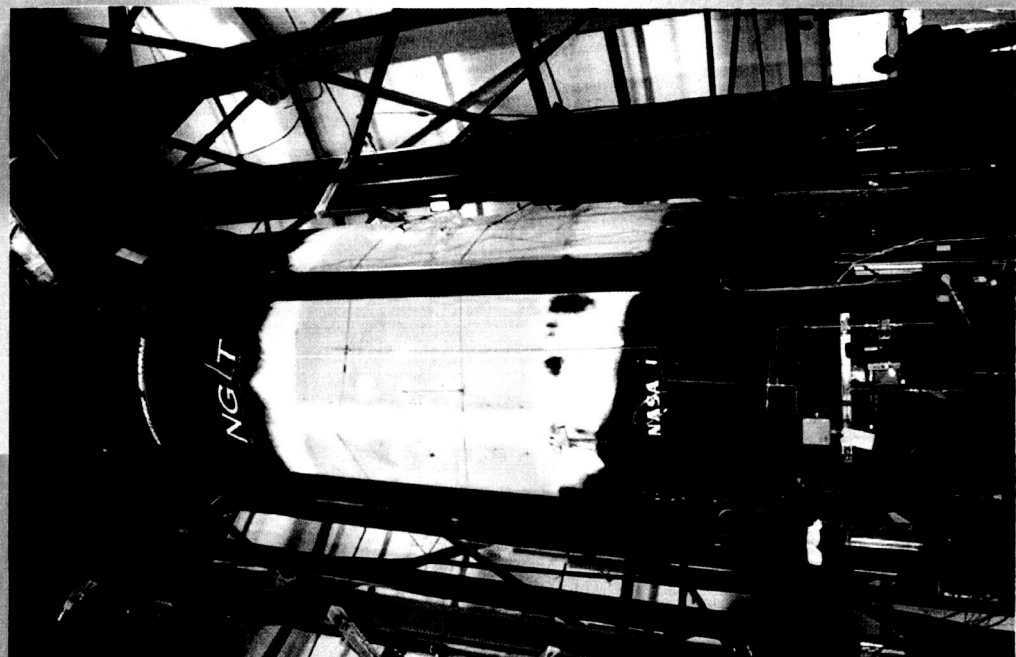
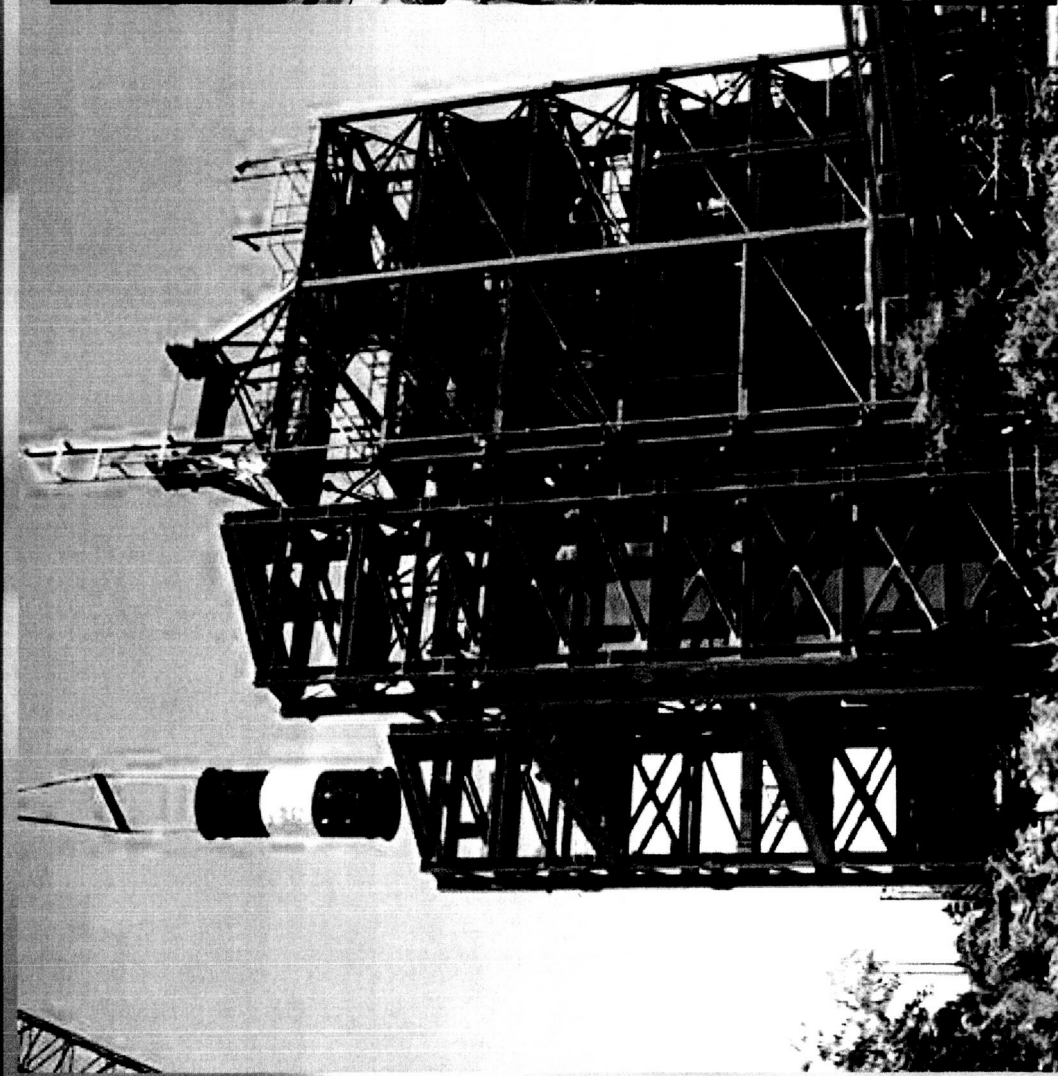
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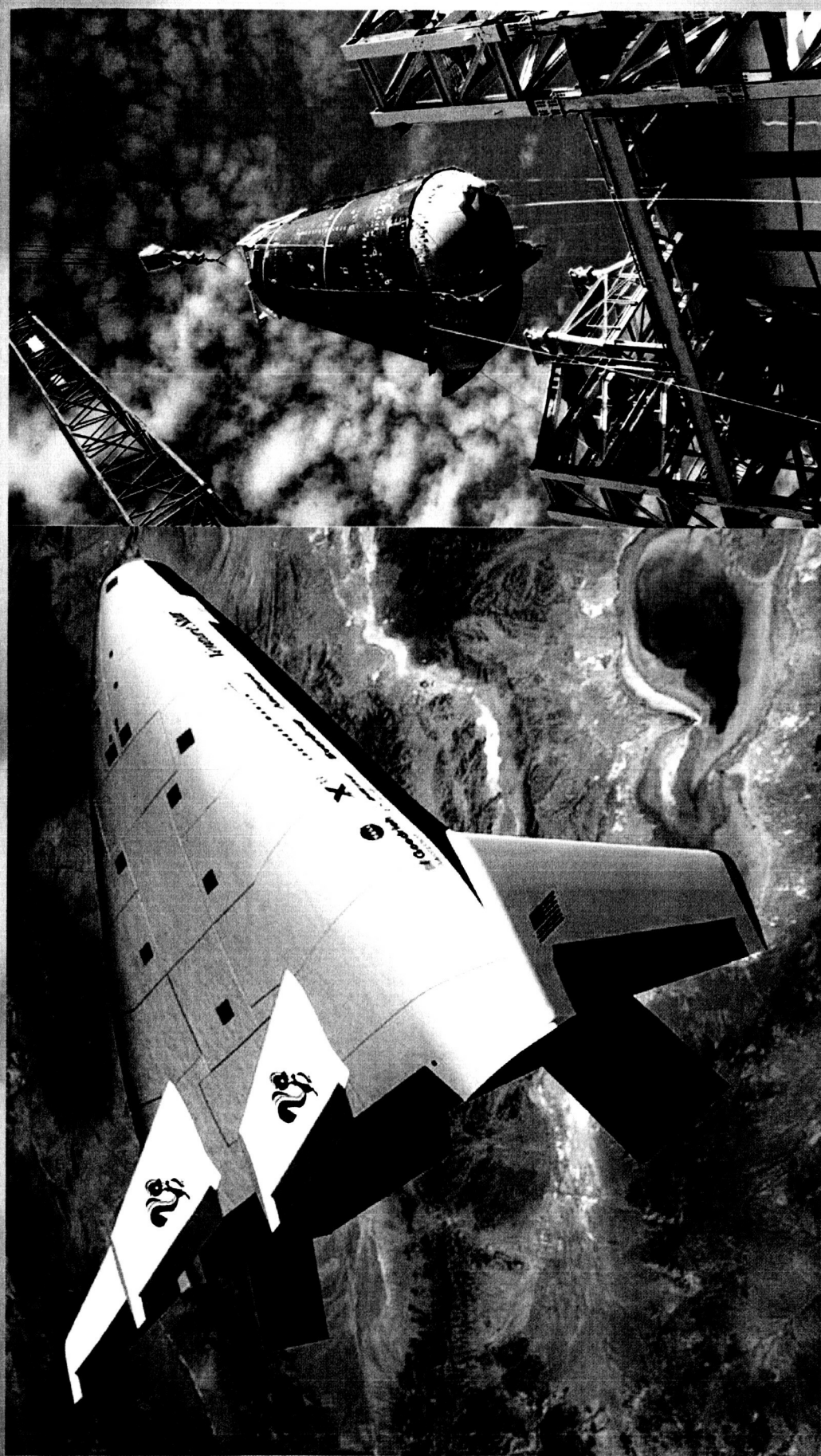
Structural Testing of the Grumman Composite Tank





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Orbiter Structural Integrity of X-33 LH₂ Tank





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Structural Steel High-Bay Facility

- **East High Bay**
 - 95 x 203 x 97 ft
 - 40 x 40-ft access door
 - 70 x 160-ft concrete reaction floor
 - 10 ft thick
 - Reaction load plates
 - Symmetrically affixed on 10-ft centers
 - 400-klbft² tension reaction capability
 - 45-klbft² shear reaction capability
 - Two overhead bridge cranes
 - Dual independent trolley hooks
 - 20,000-lb capacity
 - 5,000-lb capacity
 - 80-ft hook height

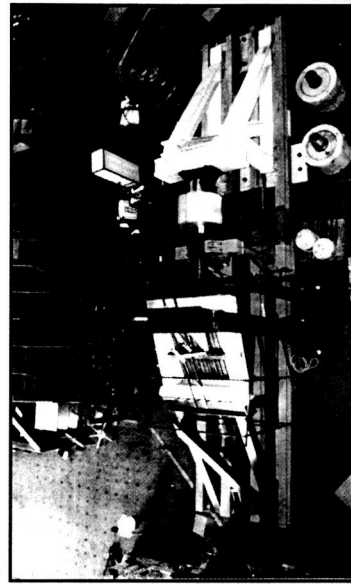
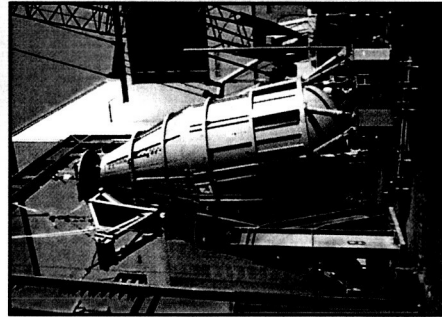
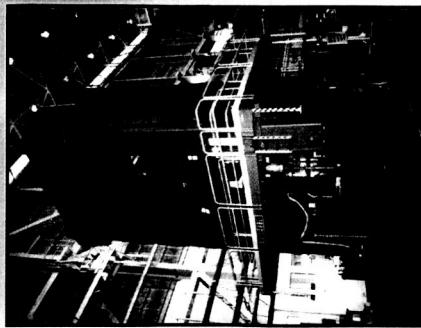




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Structural Strength Test

- **Hazardous structural test facility**
 - Full scale test articles
 - Accommodates high loads and pressures
- **Cryogenic/structural test facility**
 - LN_2 , GN_2 , LH_2 , GHe , and supplies support large volumes
 - Accommodates high loads & pressures
- **Data acquisition/instrumentation**
 - 4,600 channel capability, configurable in 256-channel increments
 - Large inventory: Load cells, pressure sensors, displacement sensors
- **Tensile test machines**
 - Tensile and compressive loads (120 klbf, 500 klbf, and 3 Milbf)
- **Modular test frames**
 - Three frames accommodate loads of 10, 50, and 100 klbf
 - Frame volumes 6, 10, and 20 ft^3

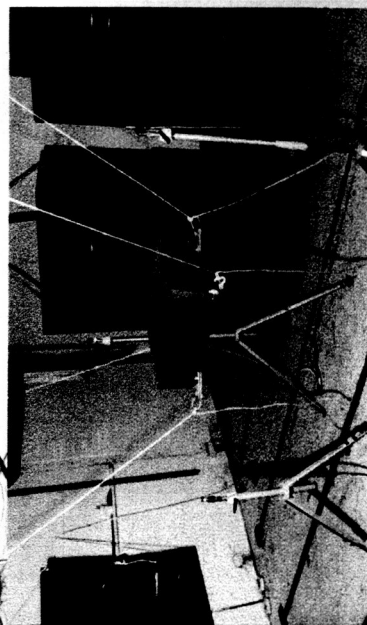
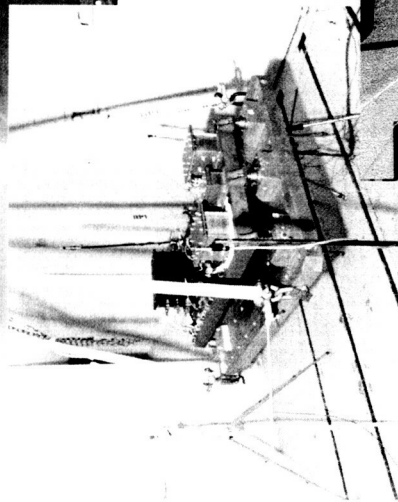
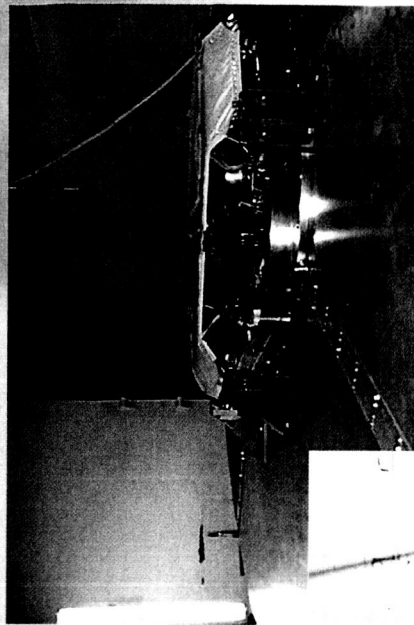




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Acoustic Test

- **Acoustic environments**
 - Diffuse field to 165 dB
 - Progressive wave to 170 dB
 - Transmissibility—Reverberation to anechoic
- **Excitation control**
 - Eight microphone channels
- **Acoustic excitation**
 - Up to 200 kW
- **Test article accommodation**
 - Up to 500 ft³
 - Access doors, 8 x 8 ft

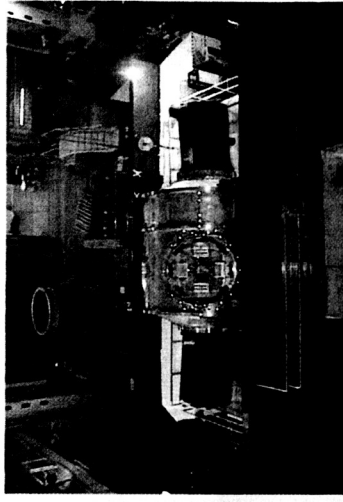
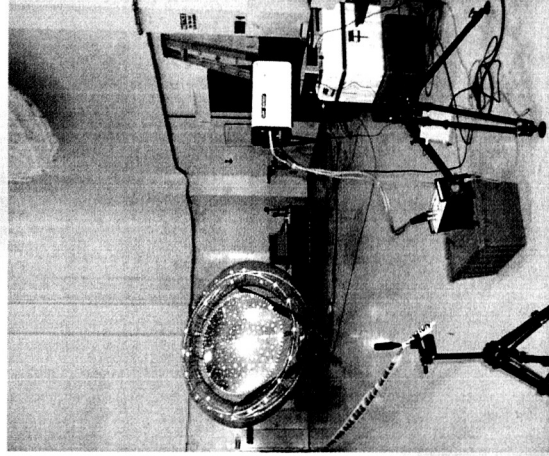
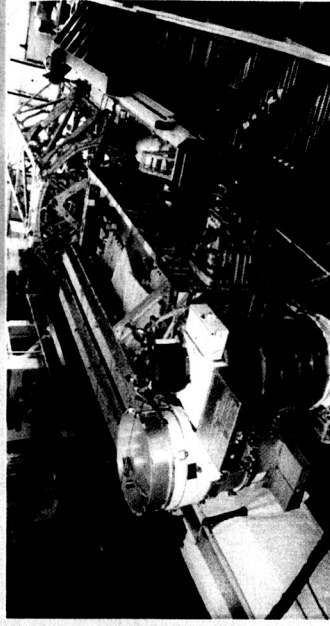
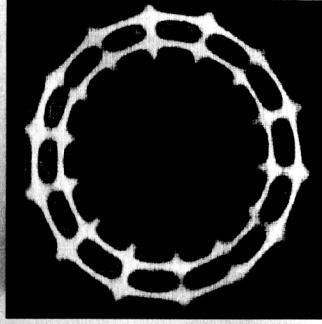




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Major Test

- **Fixed base facility**
 - Accommodates shuttle cargo bay payloads
 - 210k lbm per side fixed to bedrock
- **Holography**
 - Full field displacements (DC–35 kHz)
 - 125-nm displacement resolution
- **Component / small channel capability**
 - Fixed-base boundaries
 - Free-free boundaries
- **Scanning laser vibrometer**
 - Non-contact measurements
 - Inflatable systems dynamic characterization

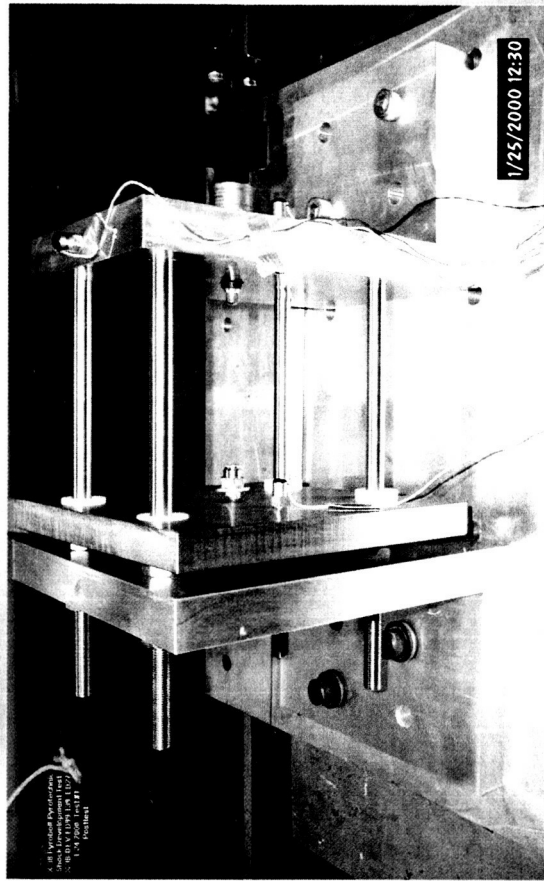
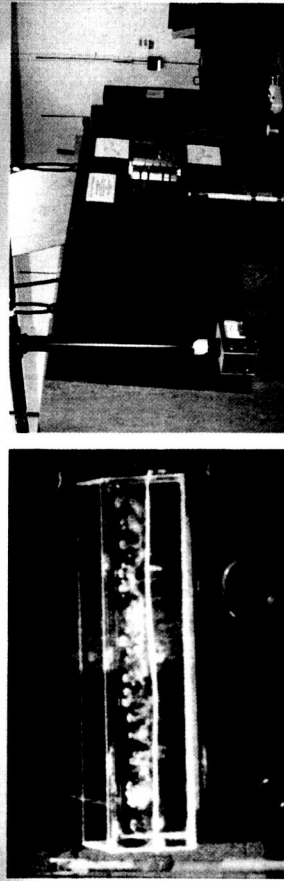




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Pyrotechnic Shock Test

- **Excitation sources**
 - Pyrotechnics generate up to 30 kg's SRS and 20 kHz
- **Accelerometers**
 - Variety capable up to 50 kg's
- **Test article accommodation**
 - Up to 500 ft³
 - Limited thermal conditioning
- **Signal conditioning and acquisition**
 - One 16 channel system for response data
- **Analysis**
 - Time and Shock Response Spectrum (SRS)

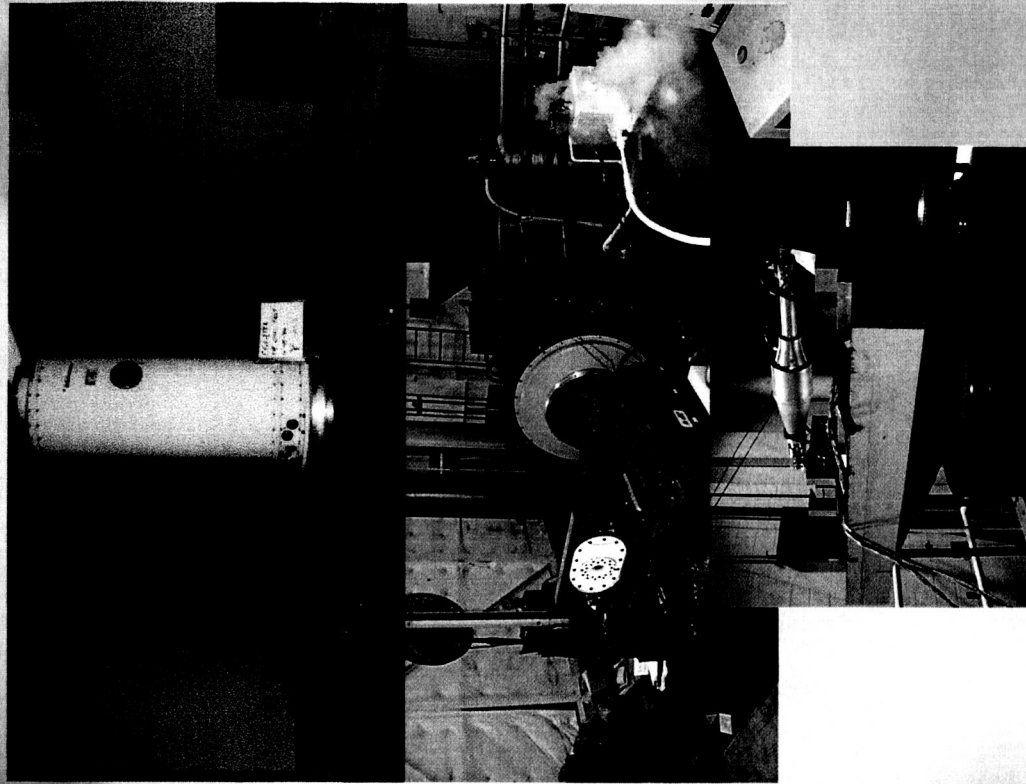




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Vibration Test

- **Excitation sources**
 - Eight electromagnetic shakers (up to 40 klbf)
- **Accelerometers**
 - Variety with capability up to 5 kg's
- **Test article accommodation**
 - Up to 5 ft²
- **Signal conditioning and acquisition**
 - Two systems w/ 32 channels of response and control data
 - Two systems w/ 16 channels of response and control data
- **Modes of vibration spectra available**
 - Sine and random
 - Sine on random and random on random
 - Classical shock and SRS



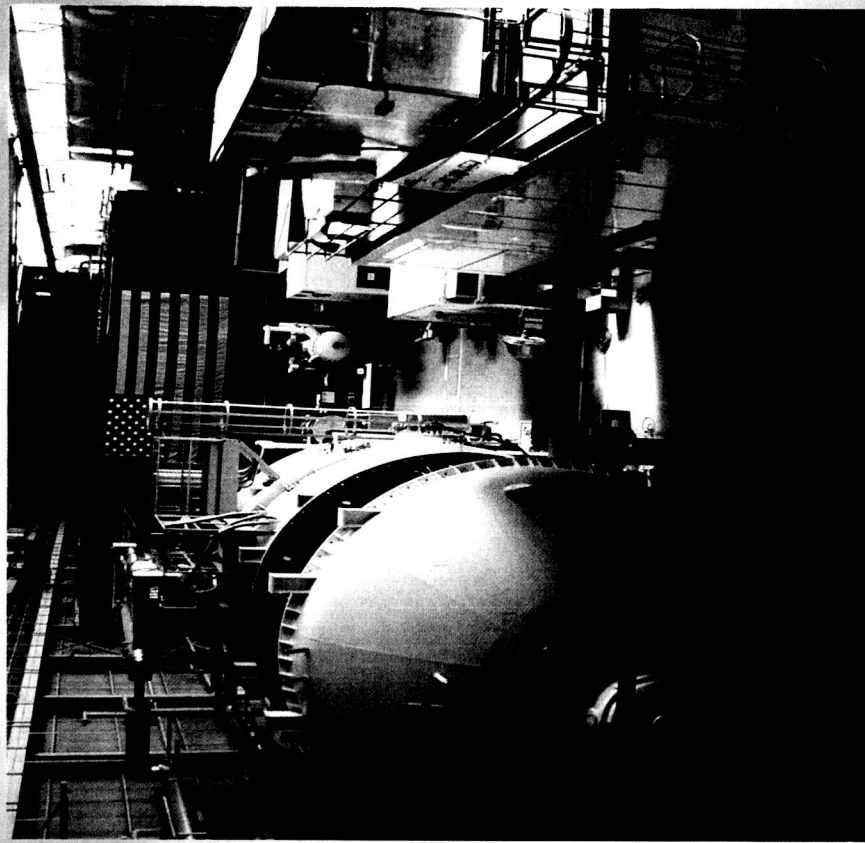


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4610 Environmental Test High-Bay Facility

West High Bay

- 70 x 150 ft
- 24 x 35-ft access door &
(2) 20 x 30-ft access doors
- 70 x 150-ft concrete 10 ft thick floor
- Two overhead bridge cranes
- Dual independent trolley hooks
 - 20,000-lb capacity
 - 6,000-lb capacity
 - 80-ft hook height





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Environmental Test Facility

The Environmental Test Facility (ETF) Provides:
Space Environment Simulation Testing
Testing on R&D and Space Flight Hardware

Test Types:

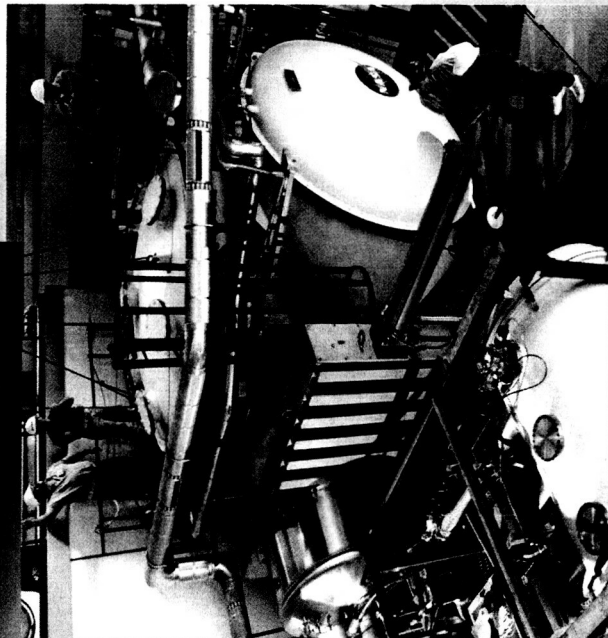
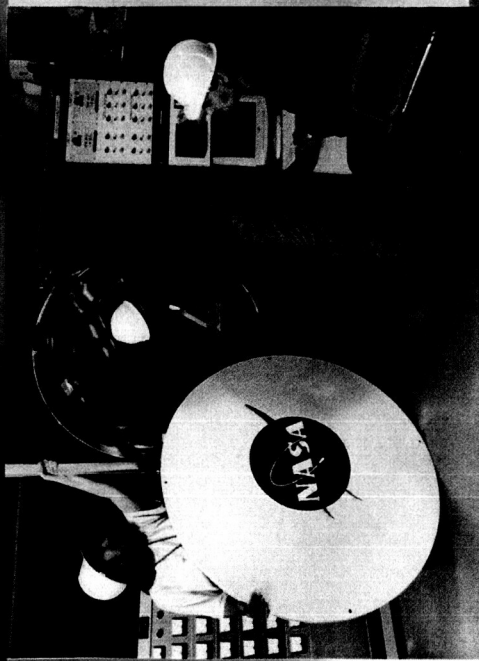
Thermal Vacuum
Vacuum Bakeout
Optical Cleanliness Vacuum Bakeout
Life-Cycle Testing
Launch Depressurization Simulation
Altitude/Thermal/Humidity Testing

Test Facilities

14 Thermal Vacuum Test Chambers
5 Thermal Humidity Test Chambers
1 Thermal Altitude Chamber
1 Class 10K Clean Room
1 Class 100K Clean Room

Performs

270-340 Tests/Test Series per Year

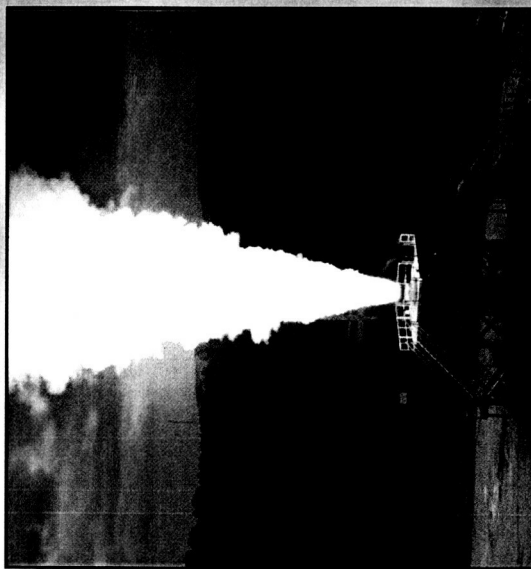




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Special Test Environment Design

Designs include test stands, test-beds, cryogenic and non-cryogenic fluid delivery systems, high pressure and/or high temperature pressure vessels and chambers, vacuum systems, load reaction and application structures, load line components, linear and rotary motion devices, R&D prototypes, flight hardware mockups and simulators, tooling fixtures, handling and transportation equipment and personnel access stands.

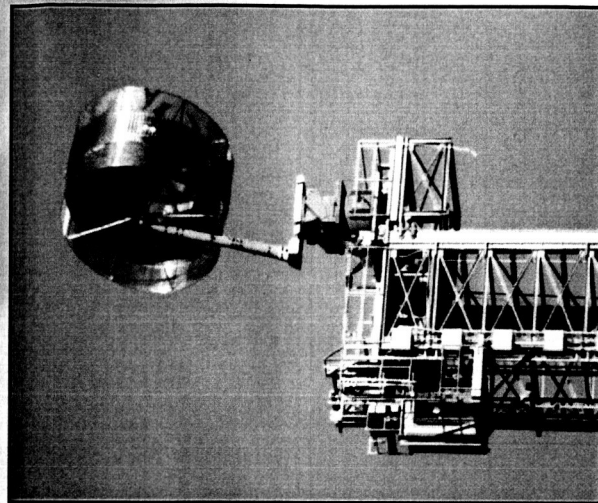
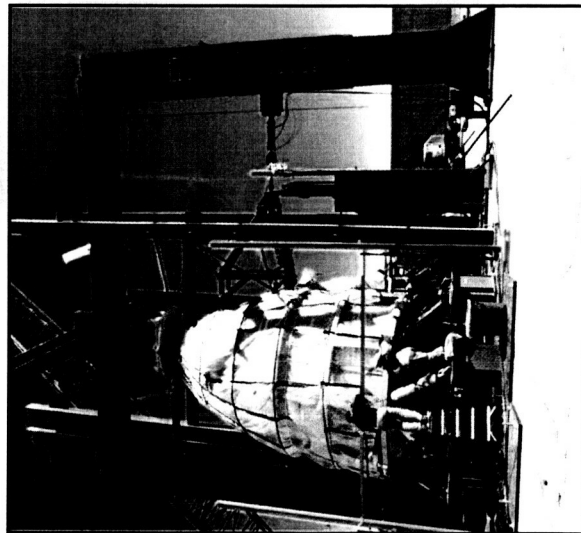


Reaction and Access Structures

Design reaction and access structures, thrust measurement systems, and motor components as the ones used for the 48" motor test.

Large Scale Structural Testing

Routinely designs complex load application and reaction hardware, including those used for the structural testing of X-33 liquid oxygen tank.



Flight Hardware Verification Testing

Design of mockups and simulators for flight verification, such as this ultra-lightweight antenna test mockup of a section of the Delta IV rocket.



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"It is difficult to know what is impossible,
for the dream of yesterday
is the hope of today
and the reality of tomorrow."

Robert H. Goddard

You are the engineers of tomorrow's reality.
Don't give up your dreams and hopes.